Part II

A car industry beyond the combustion engine
Chapter 6
Troubled waters ahead: what’s next for the European automobile industry and jobs?

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Introduction

As the European economy finally seems to have surpassed the effects of the crisis of 2008/2009, the continent’s automobile industry appears to have recovered at least some of the buoyancy of pre-crisis times. Mitigating the long-standing issues of overcapacity and pressure on prices and costs, sales and production volumes have picked up, starting from 2013, while the trade surplus and employment are growing and the profitability of the major assemblers and suppliers is again on the rise. The German automotive industry in particular has been faring rather well due to its large domestic market and export prowess. In all other major automobile-producing countries, the return to growth in production and sales is visible but the overall situation is rather mixed as the production footprint has declined in some countries while rising in others.

Despite the ongoing diesel scandal, all German original equipment manufacturers (OEMs) have contributed to and benefited from this worldwide positive dynamic. Recovery has also proved a boon for historically more vulnerable producers like Renault, which has firmly entrenched itself as a major global player, and PSA which, through its Opel deal, has completed one of the boldest European acquisitions in decades. With Asian manufacturers also strengthening their position on the continent, competition in Europe remains strong. Further exacerbating this already highly competitive situation, the automotive world is passing through a period of technology-induced turbulence that threatens to shake the industry to its core. New powertrain requirements in response to tightening environmental regulations, the potential for new uses for and expanding functionalities of cars and a new impetus towards the reorganisation of production all point to important changes to come.

This chapter focuses on these coming changes under the pressure of rapid technological development and tightening environmental regulations.

In order to establish the context for the unfolding of these technological transformations, the first section provides an assessment of the state of the industry today and of its development in the last decade.

Section two looks into the main drivers of technological transformation, with a focus on vehicle electrification and of the expected decline of the industry-defining internal combustion engine (ICE). Europe is at the forefront of the drive toward vehicle electrification, although it has begun to lose ground to China. We discuss the impact of European emissions regulations, which are going to tighten significantly by 2030.
The significance of regulatory change for powertrain technologies is expected to be nothing short of revolutionary; it is already obvious in the unavoidable decline of diesel from the status of preferred customer choice in many European countries to the trash heap of history within the span of just a few years. In the meantime, the question of what kind of technology (hybrid, battery, fuel cell) will actually replace the classic combustion engine looms large. In manufacturing, a shake-up of the upstream supplier industry is expected, considering that electric vehicle powertrains are significantly less complex than internal combustion ones and that batteries are set to become the new major contributor of added value. This reshuffling should have an important impact on employment and skill requirements in both manufacturing and R&D.

In the third section, we discuss the parallel development of vehicle automation and the arrival of the so-called mobility revolution. In this case, scenarios for the automotive ecosystem are much more radical. Anticipating huge market growth over the next two decades, major assemblers are already making heavy commitments in order to secure their positions in the upcoming segment of mobility services. Entire value chains could witness a radical reconfiguration due to the advent of shared vehicles, which are certain to have an impact on the dominant business model, on production volumes and on employment.

Finally, section four deals with current trends in the reorganisation of production under the impact of digitalisation and plans to develop the ‘industry of the future’ (‘Industry 4.0’, ‘smart factories’, etc.). Less visible to automobile users, digitalisation and connectivity are expected to have an important impact on the internal organisation of production. 3D printing, advances in software development and a growing interest in nanoelectronics have all given renewed impetus to the ideas of extensive automation. Important changes are considered in the economics of the industry, regulation, working conditions and the quantity and quality of employment.

Our main overall purpose in looking at these three changes side-by-side is to understand the impact they could have on European production and sales volumes, on the structure of the industry’s sprawling supply chains and especially on employment, skills and working conditions.

1. The state of the European automobile industry

1.1 Post-crisis recovery

Despite the protracted economic crisis of the late 2000s, ostensibly ending by the end of 2013, we can only speak about the full recovery of the European automotive market starting from 2017, when sales approached their pre-crisis peak of 2007. Similar to the 1990s, the crisis lasted no fewer than ten years. There is hardly anything surprising in this given the market’s high sensitivity to cycles of economic boom and bust (Figure 1).

The European automotive industry has witnessed significant transformations over the past decade. To take just a few examples, the emergence of central and eastern
Europe as a manufacturing powerhouse, buoyant product diversification (alongside ‘premiumisation’ and the soaring success of sports-utility vehicles – SUVs) and the unquestionable market (and, increasingly, technological) dominance of China on a global level were not exactly defining features of the industry before the Great Recession.

Figure 1  Cycles of boom and bust and the European passenger car market

![Graph showing cycles of boom and bust in the European passenger car market with key events labeled: Oil shock, Crisis of the early 1980s, Crisis of the early 1990s, The ‘toxic shock’ of the 2000s, The financial crisis, 2017/18: postcrisis peak.]

Source: Syndex calculations based on ACEA (2018) and Eurostat.

Even from a simple market standpoint, the situation in many countries is radically different to pre-crisis times and structural decline is particularly obvious in those countries hit worst by crisis and austerity (Figure 2).

Once the second largest market in Europe, Italy has witnessed a 21 per cent drop in sales since 2007, while registrations in Spain have declined by no less than 23.5 per cent. Unsurprisingly, the market in personal cars has collapsed in Romania and Greece and, apart from Czechia and Poland, sales in the new member states have stagnated regardless of their comparatively low rates of motorisation. Growth in Germany and the UK has offered only partial compensation, although this has raised their combined share of the total EU market from 36 per cent in 2007 to 40 per cent in 2017.

German OEMs have reaped the lion’s share of market recovery (Figure 3). While the Volkswagen Group increased its market share from 19.5 to 22.7 per cent, premium manufacturers like BMW and Daimler now have market shares which are equivalent to volume manufacturers like Fiat (c. 7 per cent), which has witnessed a 16 per cent drop in western European sales despite the addition of the Chrysler brands (Jeep, Dodge, Chrysler). On the other hand, Renault-Nissan has emerged as a major global player, reaching almost two million European registrations in 2017 in comparison to less than 1.5 million in 2007, a result of the revival of the low-cost Dacia brand and the success of Nissan’s vehicles. PSA has managed to stay ahead of Renault-Nissan only as a result of
its recent acquisition of Opel. Without Opel, PSA would have seen a 24 per cent decline since 2007 and a shrinkage in its market share from 13.1 per cent to just 10.3 per cent. The recent Opel sale marked the historic exit of General Motors from Europe, following Ford’s divestment of Jaguar, Land Rover and Volvo (in their turn, sales of the Ford brand declined by 21 per cent). Toyota and Honda sales have also failed to recover, while other Japanese manufacturers have struggled to maintain a foothold in the European market. In contrast, Hyundai-Kia has almost doubled its market share, from 3.3 to 6 per cent, due to a large extent to its SUV portfolio.

Figure 2  The EU passenger car market, 2007 vs. 2017 (in thousands)

In terms of production, Germany has retained its share of 33 per cent of total EU production, further distancing itself from the rest of continent, especially since France has witnessed a 31 per cent decline (from 2.55 million cars assembled in 2007 to just 1.75 million) and has lost its runner-up position to Spain (Figure 4). Belgium, Austria and Sweden are also among the losers in western Europe while, in the south, Spain and Italy have had diverging trajectories. Poland aside, the biggest growth in production has taken place in central and eastern Europe. In Czechia, Slovakia, Hungary and Romania, the automotive industry has firmly established itself as the strongest manufacturing branch and, indeed, the most important economic sector overall.
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Figure 3  New registrations by manufacturer, EU15 plus EFTA, 2007 vs. 2017 (in thousands)

Figure 4  EU passenger car production, 2007 vs. 2017 (in thousands)


Between 2007 and 2017, the EU’s trade surplus for personal cars with the rest of the world increased by 23.5 per cent, from €70.1bn to €86.6bn, largely due to an almost 50 per cent increase in the already huge German trade surplus (Figure 5).

Figure 5  **Trade surplus in passenger cars, 2007 vs. 2017 (in €bn)**

Source: Eurostat.

Figure 6  **EU trade balance in personal cars by trade partner, 2007 vs. 2017 (in €bn)**

Alongside Germany, the UK, as well as Czechia, Slovakia and, interestingly enough, Italy, have all contributed to the soaring foreign success of the European automotive industry. This was, of course, made possible by the boom in the Chinese market as well as the quick recovery of sales in the United States (Figure 6). What is perhaps less expected is the growth of exports to South Korea by no less than 547 per cent, effectively eliminating the historically large trade deficit, as well as the doubling of exports to Japan coupled with a significant decline in imports, visible in the declining sales of Japanese brands.

The recovery of the European automotive industry has thus been based, to a considerable extent, on the growing export prowess of German premium manufacturers which, alongside the VAG juggernaut, have emerged as the major winners in the post-crisis recovery at the expense of volume producers like Fiat Chrysler Automobiles (FCA) and the Japanese OEMs. After GM’s exit, only one of the US ‘big 3’ maintains large-scale operations in Europe although Ford has, likewise, significantly reduced its footprint relative to the pre-crisis period. Despite growing considerably, the situation of the two major French OEMs seems rather mixed: Renault-Nissan’s production figures have stagnated, as it has become increasingly less export-oriented, while PSA’s major decline in production and sales has been mitigated by its acquisition of Opel – a major move whose full consequences are, as yet, unclear. On the whole, uneven development has deepened, with Germany extending its leadership position and central and eastern Europe increasingly capitalising on cost-related competitive advantages at the expense of France and of southern Europe. For all industry players, these transformations seem to have been worth it, with revenues and profitability again on the rise for all but the most troubled companies.¹

In terms of employment (Figure 7), the winners are, once more, Germany and the countries of central and eastern Europe, whose integration in German supply chains has strengthened significantly. France and the south are clear losers in this respect as well. The UK is a separate case as, in comparison to pre-crisis years, it produces approximately nine per cent more cars with 28 per cent fewer employees than the average for the industry as a whole. Still, the overall balance appears to be clearly positive: from 2.2 million direct and 10.3 million indirect automotive jobs in Europe before the crisis to 2.5 million direct and 10.8 million indirect jobs in 2016 (ACEA 2008: 32; ACEA 2018: 10). ACEA data indicates that the weight of direct automotive employment in the European manufacturing industry has increased from 6.5 per cent before the crisis to 8.3 per cent in 2016.

¹. Opel is of course a notable exception, its negative results repeatedly making the headlines in the aftermath of its acquisition by PSA. PSA’s consolidated results are nonetheless strong and, at least financially, the French group appears to have fully grabbed the opportunities provided by the recovery of the European market.
1.2 Growth and profitability for all

So far, for the main European manufacturers, recovery has meant turnover growth, high profitability rates and improving returns on equity.

Renault has registered the strongest turnover growth rates since 2013, followed by Daimler and BMW (Figure 8). With a strong presence in the NAFTA region, FCA boosted its sales in 2014 and especially in 2015. PSA's growth performance is relatively weak in comparison to other manufacturers, although its sales and market share recovered in 2017.

In 2017, profitability rates converged to a relatively high level, i.e. between five per cent and ten per cent for all European OEMs (Figure 9). Rates of profitability at Daimler and BMW stood at around ten per cent. FCA, Renault and PSA increased strongly, reaching levels close to that of VAG. These performances have granted OEMs some leeway to invest and develop. Consequently, the main European manufacturers have significantly increased their capital and research and development expenditures during the last three years.

Source: Eurostat database (sbs_na_ind_r2).
2. The drivers of technological transformation

Notwithstanding the positive trajectory of recent years, feelings of uncertainty and the perception of an impending shake-up of the entire automotive establishment are widely shared among industry players and commentators.
2.1 Three simultaneous transformations

The automotive industry is currently undergoing three simultaneous transformations. First, regulatory change aimed at fulfilling climate policy objectives and improving environmental performance and public health is pushing the industry toward powertrain electrification with the potentially imminent disappearance of the internal combustion engine. Second, a ‘mobility revolution’, made possible by extensive digitalisation and vehicle electrification, entails the development of services and service provision functions alongside new connectivity and autonomous features. Such change is truly revolutionary since it has the potential to overhaul vehicle usage and ownership along with the industry’s traditional business model. Third, digitalisation across the automotive value chain promises to stretch the physical limits of flexible production even further.

At the same time, the European market is expected to grow at best incrementally over the next decades (cf. Figure 1), which means no growth in volumes while costs are set to increase significantly. Scenarios developed by the European Commission’s High Level Group ‘GEAR 2030’ estimate a drop in profit margins from approximately five per cent to two per cent in Europe between 2017 and 2030 for conventional combustion engine vehicles (European Commission 2017b: 64).

Two of the reports published by GEAR 2030 (European Commission 2017a; 2017b) emphasise the challenge of maintaining a European foothold in dynamic foreign markets given heightened global competition and the rapid advance of Chinese industrial capabilities. GEAR 2030 estimates that European players will, nevertheless, be able to grab a substantial share of the e-mobility market that is estimated to grow to $339bn by 2030 (European Commission 2017b: 114). The same goes for the market in connected autonomous vehicles which GEAR 2030 estimates at $273bn.

Such opportunities present themselves both for OEMs and for the European supplier industry. A strategy report by Continental (2018), for example, estimates that total supplier revenues from powertrain electrification and connected and autonomous vehicles will grow at a rate of 30 per cent per year between 2017 and 2030, reaching €200bn. In comparison, the established supplier business is estimated to grow at just one per cent per year over the same period. Continental singles out digitalisation as a ‘key enabler’ of these new opportunities, albeit at the cost of increased levels of its R&D and capital expenditure, by 83 per cent and 73 per cent respectively in comparison to 2012.

The unprecedented levels of investment – far above the pre-crisis period (see Figure 10) – are, in fact, a feature of the entire industry and there is widespread agreement that much more is needed over the following period.

Estimates indicate that $80bn has been invested in autonomous vehicles alone between 2015 and 2017, with an equal sum going into powertrain electrification for which Volkswagen has, by itself, announced investment of $86bn by 2022 (Deloitte 2018: 2). Industry analysts have already questioned the sustainability of such massive
investments given the industry’s persistently low profit margins and the obvious slowdown in post-crisis recovery. Further doubts arise when considering consumers’ limited willingness to pay more for new technological features, the lack of short- and medium-term returns on such investments, the still-stringent requirements of operational investments and the high sensitivity of the industry to volume fluctuations during any downturn (Giffi et al. 2017; PWC 2017a).

Cutting costs provides one way of dealing with the quandary of limited capital resources amidst growing investment requirements, and the further digitalisation of the traditional automotive value chain is one avenue of action in this regard. However, even if distribution costs can be lowered significantly and relatively easily through online sales, the digitalisation of manufacturing requires massive upfront investments on its own so it cannot function as a means to reduce financing requirements in the short-term.

One way of cutting costs is through generating economies of scale via platform sharing between OEMs, although this implies much closer collaboration than has been usual so far. A more direct approach is to enter into partnerships with the explicit aim of developing new technologies. The industry has indeed seen an unprecedented flurry of such agreements together with acquisitions, divestments and spinoffs to make the most of the available financial resources and know-how. Apart from the established players, many deals feature new entrants, including hardware and software companies, digital service providers and battery manufacturers.

However, according to the multitude of scenarios resembling futuristic literature which are currently criss-crossing the automotive world, powertrain electrification and autonomous vehicles are threatening the established automotive assemblers and suppliers in a much broader sense. Technologically-induced ‘disruption’ does not simply mean that large-scale investments are becoming increasingly risky, but rather that they have the potential to turn the entire industry on its head. Indeed, even though the automotive industry has been at the forefront of technological innovation since its inception, for many observers it is only now that genuine epochal change is happening,
as everything from the industry’s century-old business model to the car itself and its place in everyday life is expected to undergo a true test of survival in the foreseeable future.

The rest of this chapter is dedicated to the three major technological disruptions and their impacts on employment. For each of the three, we briefly describe the new technologies and the drivers behind technological innovation. We then analyse potential disruptions for the European automotive industry as well as the current knowns and unknowns that surround them. Finally, we discuss the potential scenarios for employment and for the transformation of work.

2.2 Powertrain electrification and the twilight of the internal combustion engine

Following countless announcements of tightened regulation amid the scandals surrounding diesel motorisation, it is now certain that more and more cars will be powered by electricity (or hydrogen) instead of fossil fuels and that internal combustion engines in automobiles will eventually become a thing of the past. It is also quite certain that this transformation will take several decades and that the tipping point will only be reached once charging infrastructure becomes available on a sufficient scale and electric vehicle production costs approach those of today’s conventional cars. While the disruptive potential of electrification is certainly lower and more focused than that of connected and autonomous vehicles, it has major implications for how a substantial part of the industry operates and its employment impact is still subject to controversy.

Tightening environmental regulations are the main driver behind powertrain electrification, in which regard the European Union currently maintains a clear ‘regulatory lead’ at global level (European Commission 2017b: 11). The European Commission expects environmental regulations to converge over the following decades, but it also believes that current EU policy is sufficient to provide a ‘critical edge’ to European OEMs in the rush to develop commercially viable electric vehicles.

**Which energy mix?**

There is a wide diversity of assessments concerning the future market share for electric vehicles. For 2025, estimates vary between twenty per cent and thirty per cent if we include plug-in hybrids, with battery-powered electric vehicles (EVs) to have a market share of ten per cent to twenty per cent (Figure 11).

For 2030, the disparity of forecasts is naturally much larger (Figure 12). Electric vehicles could take up thirty per cent to sixty per cent of the market. The European Commission estimates the combined market share of battery electric vehicles (BEV) and plug-in hybrids (PHEV) at fifty per cent by 2030. In the long run, it is expected that BEVs will dominate all regional markets. In most scenarios, BEVs appear as the primary solution for electrification. Given the bans on combustion engines in some major European urban areas (Paris and London included) that have been announced
for 2030, it is likely that hybrid powertrains will serve merely as a temporary solution, facilitating both the technological and the social transition to pure electric vehicles.

Figure 11  Variability of market forecast for 2025 in Europe

![Variability of market forecast for 2025 in Europe](image1)

Source: Syndex.

Figure 12  Variability of market forecasts for 2030 in Europe

![Variability of market forecasts for 2030 in Europe](image2)

Source: Syndex.
Indeed, for the European Commission (2017a: 36), plug-in hybrid vehicles are expected to play a major role in the shift to purely electric automobiles and are widely regarded as ‘an important transitional technology’. For OEMs, hybrids offer the opportunity to invest in both EV (required to meet future regulatory requirements) and ICE (required to secure present-day profitability) technology, although regulation will eventually make continued ICE investments unfeasible from both operational and financial points of view.

However, uncertainties concern both the technological (battery density and autonomy) and the economic aspects of battery-powered electric vehicles. At present, BEVs are still far from being as cost-effective and as usable as conventional automobiles. The high cost of batteries, which can currently take up forty to fifty per cent of the total cost of an EV (Kochhan et al. 2017: 4), make non-premium electric automobiles prohibitively expensive despite the incentive schemes set up by many European governments. This should not last long, as the total costs of vehicle ownership and the OEM profitability of EVs is expected to be on a par with those of conventional automobiles before 2025 even without state incentives (UBS 2017: 44). For example, Renault, the European leader in BEV development, anticipates in its most recent medium-term strategy plan (‘Drive the Future’) that, by 2022, the costs of the battery packs of new e-motors will decrease by thirty per cent and twenty per cent respectively.

Battery technology is expected to improve alongside declining costs, but the estimated $14bn needed in Europe just until 2025 for setting up the required charging infrastructure (UBS 2017: 16) remains a big unknown.

For the next decade, the Commission is emphasising the crucial role that regulation and rapid EV development should have in protecting the European market from low-cost foreign entrants and in securing a presence on foreign markets for European OEMs. With strong advances in EV technology, China is particularly threatening in both regards. The question of how European manufacturers will respond to these new threats is thus vital for the fate of the industry.

**Shifting content in BEV solutions**

Full powertrain electrification puts in question dozens of engine and transmission plants across Europe. According to the most recent ACEA data (Figure 13), there are 63 engine plants in Europe with the largest concentrations in Germany (twelve), France (seven), Italy and the UK (eight each).

In a BEV, the combustion engine is replaced by a battery coupled to an electric motor, while a simple one- or two-speed integrated transmission replaces the highly-complex mechanical transmission required in ICE cars. In such conditions, the sustainability of the existing powertrain industrial infrastructure is under serious threat.

While the electric motor is simple to manufacture and, as it seems, many OEMs will opt to produce it in-house, major questions still surround battery production. Even with the expected cost reductions of a rapid transition to EV dominance, long-term
forecasts indicate that batteries will continue to represent 25 per cent of the total cost of a car in 2050 (European Commission 2017b: 86). It is improbable that OEMs with no previous contact with electrochemistry will invest in battery production, so battery suppliers are expected to play a major role in the EV ecosystem. Indeed, it is relatively easy for battery makers to supply not just the battery but the entire powertrain, as is already the case with the Chevrolet Bolt, where no less than 56 per cent of the car’s total content comes from LG (UBS 2017). Battery commoditisation is still a possibility but, if it remains the high-tech, difficult-to-manufacture product that it is today, this could spell the end of the traditional power structure between suppliers and OEMs as the latter will find it increasingly difficult to boost margins by pressuring the former to reduce prices. The future of the battery market is difficult to predict as yet, although for OEMs this is certainly a key strategic dilemma.

Figure 13  Engine plants in Europe

On the supplier side, the arrival of battery producers will be followed by the disappearance of a large array of ICE-specific components (Figure 14): a BEV has no need for a fuel tank, a fuel pump, a turbo or an exhaust system, a clutch, an emissions
control system, air and oil filters, or any of the standard components of a combustion engine (valves, crankshaft, camshafts, etc.). A recent study (UBS 2017) shows that an EV powertrain has six times fewer moving parts and is thus mechanically far simpler than a standard ICE powertrain. At the same time, it is significantly more complex from an electronic point of view and contains up to ten times more semiconductor content. New major parts include converters, inverters, power distribution modules, electric drive units, motor cooling systems and chargers. As mentioned already, the transition via PHEVs will prevent a zero-sum game between ICE and EV value chains for some time to come but, in the long run, the sizable powertrain supplier industry will be overhauled by the shift to pure electric vehicles. The significant decline of spare parts and aftermarket activities resulting from the diminished number of wearable parts in the EV powertrain will further contribute to this.\footnote{Estimates indicate a drop of no less than sixty per cent of the revenue pool of after-market activities (UBS 2017).}

2.3 Employment impacts of vehicle electrification: a qualitative approach

Syndex’s analysis of the situation and strategies of the main automotive OEMs and suppliers in Europe indicates that the social impact of powertrain electrification is likely to be mixed (Table 1).
In the short-term, the prospect of a tightening of regulation will boost investments in new ICE technology and in hybrid powertrains, alongside a continued shift from diesel to petrol motorisation. These should all have a neutral, or even slightly positive, impact on employment in production (for example, the new ‘Euro 6d-temp’ norm requires additional exhaust treatment, equipment and sensors).

**Table 1**  
**Powertrain employment impacts: diverse and contradictory dynamics**

<table>
<thead>
<tr>
<th>Production</th>
<th>R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Today</strong></td>
<td></td>
</tr>
<tr>
<td>Implementation of EURO 6d-temp – new equipment;</td>
<td>A lot of work for powertrain teams (test + norms adaptations)</td>
</tr>
<tr>
<td>Limited hybrid impacts on assembly activities (but complexity, intensity of work)</td>
<td>Mobility (diesel/ gasoline), diesel decline</td>
</tr>
<tr>
<td>Limited volumes of BEV, low productivity</td>
<td>Emergence of EV/FCEV teams + adaptation of all the vehicle functions to an electrical architecture</td>
</tr>
<tr>
<td>More Gasoline/Less Diesel Volumes</td>
<td>Diversified powertrain solutions (Full electric, Hydridized, Thermal)</td>
</tr>
<tr>
<td></td>
<td>Divestiture (volunteer departure; partnerships; externalisations...)</td>
</tr>
<tr>
<td><strong>After 2021</strong></td>
<td></td>
</tr>
<tr>
<td>More BEV volumes</td>
<td>Decline of ICE projects</td>
</tr>
<tr>
<td>Depends on the speed of electrification and the share of hybrids (MHEV, PHEV, FHEV)</td>
<td>More EV/FCEV projects</td>
</tr>
<tr>
<td>Depends on the battery production contribution</td>
<td>New R&amp;D domain (next generation of battery, quantum computing...)</td>
</tr>
<tr>
<td>New strategic suppliers (batteries), but shorter supply chain</td>
<td></td>
</tr>
</tbody>
</table>

Source: Syndex.

In R&D, the short-term impact of the transition toward EVs should also boost employment, given the focus on adapting to new environmental regulations and tests, the emergence of dedicated EV teams, the diversification of powertrain systems (ICE, hybrid, pure electric) and the need to adapt all vehicle functions to EV architecture. On the less positive side, the transition from diesel to petrol should involve some transformation of existing competences, while the expected decline of R&D in ICE technology could lead sooner rather than later to voluntary leaver plans.

We believe that the medium-term impacts – i.e. following 2021 and the implementation of new environmental regulations – will be negative for employment. In terms of R&D, the reduction in the number of combustion engine platforms and the lack of certainty concerning future generations of plug-in hybrid powertrains will limit the need for new R&D resource allocation. In parallel, the development of electrified powertrains, and especially battery systems, will continue to grow but will require smaller R&D teams with higher technical abilities than for combustion engines. Such expertise usually lies within the purview of actors outside the automotive industry.

In production, the simplification of manufacturing processes is likely to lead to a decline of employment both in OEMs and in suppliers, although the extent of this will
depend on the pace of the transition from ICE to BEVs — during the transition, the rise of hybrid vehicles will actually increase the complexity.

The extent of overall employment decline is also likely to depend on the capacity of the European industry to develop electrochemical operations related to battery development, which could take up between four and seven per cent of automotive employment in the future (see below).

For now, however, the positive employment effect of co-existing ICE and EV powertrains, with continued ICE development to keep up with environmental regulation and the shift from diesel to petrol, implies higher workloads. Given the need for OEMs to compensate for still-barely profitable EV portfolios, this situation is bound to persist at least into the first half of the 2020s.

**Diverging estimates of employment impacts**

Almost all the available estimates on the overall impact of vehicle electrification on employment at European level are positive (see European Commission 2017d: 51) and the forecasts of the European Commission make no exception in this regard (Table 2). Depending on the CO₂ emissions reduction scenario, by 2030 the total number of jobs in the European economy is expected to increase in a range between 18,000 and 86,000. For the automotive sector itself, the forecast employment effect becomes increasingly negative as the level of emissions reduction and powertrain electrification increase (job losses of between 3,000 and 12,000). It needs to be emphasised that both positive and negative employment forecasts are extremely modest (less than one hundredth of one per cent for the European economy and less than half of one per cent for the European automobile industry).

Far more optimistic scenarios have been published, with the European Climate Foundation (2018) estimating that 206,000 jobs will be created by 2030. The most positive scenarios involve a ‘net increase in employment across the economy of 500-850 thousand’ (Transport & Environment 2017). This is largely attributed to the redirection of a substantial part of household budgets from fossil fuel spending, freeing purchasing power for other industries and the service sector. As fossil fuels are largely covered by imports, the underlying assumption is that only four European jobs are created for each €1m of value added in the petroleum industry, in comparison to 24 jobs on average for the whole economy. Growing R&D employment and additional jobs in the infrastructure sector required for EVs are also believed to have a positive impact on overall employment levels. The same estimate indicates that maintaining current levels of automotive employment is possible and could even increase if Europe becomes a net exporter of EVs and if battery production remains local. In both regards, China represents the only potential threat at the moment. Fully importing batteries would reduce European automotive employment by six to seven per cent by 2030, according to some estimates (Transport & Environment 2017: 4) or by four per cent (100,000 jobs) in others (European Commission 2017b: 88).
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As for the automotive sector per se, there is a widespread consensus that the growth of EVs will lead to employment decline, especially in the long-term when the temporary positive employment effects of hybrid technology would have dissipated. The differences between optimists and pessimists are much more obvious in this regard. One recent study suggests that electrification could lead to a reduction in employment of ‘around 60 per cent in powertrain, spare parts manufacturing and maintenance’ (FTI Intelligence 2018: 1). Pessimistic scenarios involving a full move to pure electric vehicles have estimated job losses at around 600,000 in Germany alone (Cramer 2017), where 58 per cent of automotive manufacturing is ‘dependent’ on the conventional combustion engine (FTI Intelligence 2018: 2). One German OEM has indeed suggested that electric motor manufacturing requires between eighty and ninety per cent fewer employees than ICE manufacturing (FTI Intelligence 2018: 11).

The employment impact will most certainly be uneven, especially among tier 1 suppliers. Industry analysts (UBS 2017) assessing the preparedness of suppliers for the EV challenge have emphasised that some have already lost plenty of ground while others are set to emerge as major winners. Continental, for example, estimates it will have 400 per cent more content in a BEV than in a standard gasoline ICE automobile (Continental 2018). In addition, battery manufacturers could gain significant leverage by grabbing sizable parts of the upstream value chain, leaving many existing tier 1 suppliers completely outside powertrain manufacturing. Consequently, even in the more optimistic scenarios in which European automotive employment will not change significantly, it is unlikely that all of today’s major players will enjoy a smooth transition.

The question of unevenness is also a spatial one, as European automotive employment is highly concentrated geographically (Figure 15; see also Figure 13). A study by FTI Intelligence (2018: 17) mentions fourteen regions in which automotive employment exceeds twenty per cent of total manufacturing employment. A strong negative impact on automotive employment will hit these regions particularly hard and important structural changes could happen even where current overall levels of employment are

Table 2  Employees in atypical and standard jobs, 2000-2015 (in 000)

<table>
<thead>
<tr>
<th>CO₂ emissions reduction target</th>
<th>20%</th>
<th>30% cars / 25% vans</th>
<th>40%</th>
<th>20%</th>
<th>30% cars / 25% vans</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum refining</td>
<td>151</td>
<td>-1</td>
<td>-1</td>
<td>-0.2%</td>
<td>-0.3%</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Automotive</td>
<td>2,454</td>
<td>-3</td>
<td>-12</td>
<td>0%</td>
<td>-0.1%</td>
<td>-0.5%</td>
</tr>
<tr>
<td>Rubber and plastics</td>
<td>1,776</td>
<td>+5</td>
<td>+7</td>
<td>+0.3%</td>
<td>+0.3%</td>
<td>+0.4%</td>
</tr>
<tr>
<td>Metals</td>
<td>4,288</td>
<td>+5</td>
<td>+5</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td>+0.1%</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>2,451</td>
<td>+5</td>
<td>+7</td>
<td>+0.2%</td>
<td>+0.3%</td>
<td>+0.5%</td>
</tr>
<tr>
<td>Electricity, gas, water, etc.</td>
<td>2,52</td>
<td>+2</td>
<td>+2</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td>+0.2%</td>
</tr>
<tr>
<td>Other sectors</td>
<td>200,427</td>
<td>+3</td>
<td>+69</td>
<td>+0.01%</td>
<td>+0.001%</td>
<td>0.03%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>230,209</td>
<td>+20</td>
<td>+86</td>
<td>+0.01%</td>
<td>+0.01%</td>
<td>+0.04%</td>
</tr>
</tbody>
</table>

maintained. It must also be kept in mind that, even if the internal combustion engine is here to stay for at least two decades, both as a standalone option and as a part of hybrid powertrains, there is a risk that ICE technology will become commoditised and even shared among OEMs focused on EV development. Commoditisation could lead to the further delocalisation of ICE manufacturing to low-cost countries in central and eastern Europe. Such cases of west-east delocalisation due to ICE decline already exist, exacerbated by the diesel scandal (Tighe 2017).

Figure 15  Number of automotive employees (FTE) by region, 2015

Source: DG Growth cluster mapping tool.

3. Connected and autonomous vehicles and the impending ‘mobility revolution’

3.1 The technology landscape

The technology for connected and autonomous vehicles (CAVs) has far more disruptive potential for the automotive industry than powertrain electrification. The shift to shared and autonomous vehicles is genuinely revolutionary for an industry that
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has, from its inception, been dependent on the manufacture and sale of privately-owned, human-driven automobiles. In contrast to the case of EV development, where regulation is the major impetus behind technological innovation, CAV development is being pushed mainly by technological innovation while the question of workable regulatory frameworks for fully autonomous vehicles remains a big unknown. And even though the technology for autonomous vehicles might take longer to develop than that of electric powertrains, there is no technological uncertainty like those concerning EV range and charging infrastructure. The major uncertainty thus concerns the survival of the existing automotive business model, as current automotive revenues and profits would shrink in favour of mobility services while car manufacturers face increased competition from technology companies.

Existing connected vehicle technology is practically harmless and, in itself, only adds secondary functionality without threatening the industry or established ways of using vehicles. As a general principle, ‘Connected cars are those that have access to the internet and a variety of sensors and are thus able to send and receive signals, sense the physical environment around them, and interact with other vehicles or entities’ (PWC 2016: 10). Today’s connected features include infotainment, GPS and parking assistance while those of tomorrow might include advanced human-machine interfaces (HMI) and augmented reality. Existing connected vehicles already feature complex sensors and increasingly greater processing capacity, while dedicated operating systems and in-vehicle apps are not that big an innovation in the smartphone era. Indeed, PWC (2017: 8) estimates indicate that, in 2017, 89 per cent of new cars sold in Europe, China and the US had such basic connectivity features with 100 per cent to be reached by 2022.

As connectivity technology matures, increasingly more features will become available to middle and entry market segments, becoming part of the basic price list (see Figure 16). Connectivity hardware, in particular, may well become commoditised, with falling revenues and profitability, while the market in digital services could stagnate, at least in comparison to more sophisticated connected technology like shared mobility (Figure 17). Vehicle software content is expected to increase substantially and could even replace the car’s body and traditional functionality as the key differentiator between products. More software content will mean that connected cars will begin to generate massive amounts of vehicle and customer data, which could be used to provide tailored services (e.g. insurance adapted to driving style) and improved vehicle performance and usability (e.g. predictive maintenance). Although this extension of the traditional automotive value chain is already tangible, it is still uncertain whether OEMs will secure control over in-vehicle software and the data it generates. It is equally possible that they will have to give ground to technology companies looking to expand their dominance into an emerging field of activity, threatening to confine OEMs and traditional suppliers to the manufacture of increasingly commoditised vehicles and hardware.
Connectivity between cars and their environment and interaction between cars are key elements in the development of autonomous vehicles for which integrated computer hardware and software provides anything from simple assistance (Level 1) to full automation without any intervention from users (Level 5).³

Leaving aside the potential for vehicle sharing, autonomous vehicles do not in themselves represent much more of a threat to established industry players and business models than connected vehicles. They require significant investments in both software and hardware (driver assistance systems, for example, require new chassis technology) and could allow technology companies to enter the automotive market, but otherwise they are not inherently threatening to the way the industry has been operating for more than a century. In these terms, the main risk is probably a result of financing competition between automation, connectivity and electrification.

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³ Basic driver assistance is already available in three-quarters of new cars sold (Figure 17). Equipped with already-existing technology, partially (Level 2) and highly autonomous (Level 3) vehicles, still requiring substantial intervention from human drivers, are expected to become dominant by 2025 while fully autonomous vehicles (Level 4, where a human driver may still be required to intervene; and Level 5, where the car can operate completely driverless under all circumstances) are estimated to become available only toward the end of the 2020s.
Fully autonomous vehicles would allow more users (including those unable or unwilling to drive) to benefit from automobility, while offering substantial cost savings largely due to eliminating the cost of the human driver’s time (Figure 18; Corwin et al. 2015: 12). Even more significant savings could be achieved from a shift to shared and autonomous vehicles, the development of which is also a consequence of advanced vehicle connectivity: the cost per kilometre for shared autonomous vehicles is estimated at less than one-third of that of personally-owned and human-driven cars. PWC (2017b: 17) estimates indicate that, between 2017 and 2030, the development of autonomous and shared vehicles will increase the total distance driven in the EU and US combined by 23 per cent, although by 2030 the number of kilometres driven which are attributable to personally-owned and human-driven vehicles will still be less than one-half of the total (Figure 19).
A more intense usage of shared vehicles will mean that greater distance will be covered using fewer cars, while the same source (PWC 2017b: 18) estimates a drop by 25 per cent in the number of vehicles in use in the EU and US combined (35 per cent if we consider only personally-owned, human-driven vehicles). In such a scenario, PWC estimates that vehicle sales would actually increase by 28 per cent due to higher turnover for shared vehicles, and especially for shared autonomous ones.

It might seem counter-intuitive, but many industry analysts (e.g. PWC 2018a; Roland Berger 2015) support the view that vehicle sales will go up due to the uptake of shared and autonomous vehicles. While this is not that implausible in currently highly-saturated markets like Europe given even a moderate increase in the popularity of shared and autonomous vehicles, scenarios that involve a more significant advance of these new technologies do indeed indicate a decline in sales. For example, in a ‘100 per cent robotaxi’ scenario (in which all vehicles in use would be shared and automated), PWC (2018a: 35) estimates a drop in the number of vehicles in use to a mere 14 per cent...
of current levels, while new car sales would decline by no less than 50 per cent. In such a scenario, the transformation of the automotive industry would be even more profound as tomorrow’s ‘robotaxis’ have high chances of being very different from today’s cars.

A forecast on market structure (Roland Berger 2015) suggests that market polarisation could be pushed to the extreme by the development of shared and autonomous vehicles: non-shared vehicles would be reserved for the premium segment while the large segment of shared vehicles would comprise only nondescript ‘low-cost pods’. This would squeeze existing volume OEMs and push them in one of these two directions: becoming either premium producers or simple hardware manufacturers.

CAV technology is thus expected to develop from conventional automobiles with simple in-vehicle digital services to a genuine revolution in the way cars are used and sold. Mobility services are expected to become the most dynamic and profitable side of the automotive ecosystem, with annual revenues of $467bn in Europe by 2030 (PWC 2017b: 19), in comparison to $25bn in 2017. Shared mobility, digital services and software would account for no less than 37 per cent of profits (Figure 17), while only 49 per cent would be attributable to the industry’s traditional core activities (vehicle sales, finance and after-market). All this takes into account that fully autonomous vehicle technology is not expected to reach maturity until the end of the 2020s and that ‘robotaxis’ will not be able to gain any significant presence until then. Such scenarios are accompanied by warnings of a so-called ‘Kodak’ or ‘Nokia’ moment in the automotive world, when

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4. The less pronounced decline in sales would be due to higher vehicle turnover caused by more intensive use.
traditional players fail to shift the focus of their business models from one-time product sales to mobility service provision. The risk for automotive OEMs and suppliers is that technology enterprises (whether or not they are existing mobility service providers, like Uber) will become dominant in the mobility service market while they remain confined to manufacturing predominantly low-revenue and low-profit white-label vehicles.

There is thus a high level of uncertainty regarding the ultimate outcome of these transformations and especially as to the abilities of OEMs to respond to the challenge of the much-anticipated mobility revolution.

### 3.2 Employment impacts of the mobility revolution

The employment impact of CAV development will largely depend on the outcome of the future ‘battle of the business models’ (PWC 2016: 63) and reliable estimates are difficult to put together as yet. Some tendencies can indeed be discerned, although they do not necessarily point in the same direction.

The need to finance large-scale R&D investment and gain know-how in connectivity and software development has led most OEMs and many large suppliers to engage both in partnerships and in mergers and acquisitions (PWC 2016: 35-36). This has also had an important impact on employment, as both OEMs and tier 1 suppliers have begun to hire large numbers of engineers and IT specialists and even open entirely new R&D centres focused on CAV products, including connectivity, apps, driver assistance systems, artificial intelligence, etc. The employment impact of CAV technology is yet to be felt in production and will likely not play a role until the second half of the 2020s, when CAV technology and its accompanying regulatory frameworks should be advanced enough to make widespread use of shared vehicles feasible. Even so, as discussed above, the impact on automotive employment is uncertain and depends on the extent to which shared mobility services will replace conventional personal transportation and whether traditional automotive players manage to secure a position in the reconfigured mobility value chain.

A recent forecast (Deloitte 2017; Figure 20) suggests that the successful dominance of OEMs over the extended automotive value chain could mean that, by 2025, nearly 12 per cent of OEM employment could be comprised of data and mobility IT specialists with manufacturing, after-market and sales dropping to 77 per cent (from 89 per cent today, with total OEM employment dropping by two per cent). The toughest scenarios for OEMs involve them becoming primarily hardware producers focused mostly on manufacturing white-label, nondescript vehicles meant to act either as hardware platforms or basic hardware support for new mobility service providers. The advent of low-cost pods dedicated to shared mobility services could lead to a significant drop in manufacturing employment (a decline of between 30 and 40 per cent), even if overall sales increase as a result of more intense vehicle utilisation and turnover. This would be the case because manufacturing would have to become more flexible and more easily deployable according to the needs of mobility service providers, while reduced complexity and product diversity would provide a further impetus to automation in production.
In production, the mobility revolution will have limited impact in the short-term (as Table 3 shows) but, starting with the second half of the 2020s, the advent of shared and autonomous vehicles could determine a drop in automotive employment due to reduced sales and increased automation in the manufacture of dedicated shared vehicles. R&D investment in CAV technology has already had positive effects on employment levels, although this means automotive OEMs and suppliers have to gain competences that they previously considered to be secondary at best, including in connected systems and software, data management, AI, machine learning, cybersecurity, etc. The rise of mobility services is likely have only a limited positive impact on employment since some functions (e.g. call centres) may well be outsourced and others automated. The
most significant negative impact is likely to occur in sales, where physical dealerships will be increasingly replaced by virtual ones and digital sales services will gain more and more ground over traditional sales instruments.

Table 3  Mobility employment impacts: progressive changes

<table>
<thead>
<tr>
<th>Production</th>
<th>R &amp; D</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Today</strong></td>
<td>![Limited impacts]</td>
<td>![New services, new technological modules: ADAS, software and connected systems ...]</td>
</tr>
<tr>
<td><strong>2022+</strong></td>
<td>![Shared vehicles: new constraints of production]</td>
<td>![Weight reduction and durability issues]</td>
</tr>
<tr>
<td>![Less volume]</td>
<td>![Agile organisations]</td>
<td>![Digital tools of commercialization]</td>
</tr>
<tr>
<td>![More electronic components, produced on automated lines]</td>
<td>![Digital &amp; Data engineering, IA, machine learning, Cybersecurity]</td>
<td>![Decrease of physical dealership networks]</td>
</tr>
<tr>
<td>![Externalisation of back office activities (call center)]</td>
<td>![New actors and solutions of mobility services, with limited job content]</td>
<td>![Sales more focused on service provision than on cars per se]</td>
</tr>
</tbody>
</table>

Source: Syndex.

4. The digitalisation of the production process

The hype about increasingly digitalised automotive products and services embodied by CAVs has displaced manufacturing itself from the industry headlines, even though vital changes due to the digitalisation of production processes had been announced several years before connected and autonomous vehicles became a tangible reality. The by now relatively old idea of Industry 4.0, or Industry of the Future, referred to the full digitalisation of the traditional automotive value chain, from procurement and logistics to sales and after-market operations. A recent comparative assessment of industries’ ‘digital maturity’ indicates that the automotive industry is well ahead of other manufacturing sectors although, overall, the European automotive industry appears to be less ‘digitally mature’ than the American or Asian ones (PWC 2018b: 15).

4.1 The plant of the future: a combination of technological innovations

Multiple technologies are being vaunted as necessary for a digitalised automotive production system (Figure 21). Connected logistics promise to take just-in-time production to a new plane, with the real-time coordination of multiple links across the value chain from incipient customer interests to upstream suppliers. It is not just by accident that this may sound highly familiar: many of the expected benefits of increased digitalisation actually concern the fulfilment of even more of the promises of so-called flexible, just-in-time manufacturing tailored as close as possible to changing customer needs.
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Towards a just transition: coal, cars and the world of work

Figure 21 The digitalised automotive production system

Source: adapted from Gimélec (2014).
Digital technology is supposed to contribute to even fewer defects and improved reactivity while allowing manufacturers to provide personalised goods and services to customers whose consumption needs and habits can be assessed in real time via analytics systems based on ‘big data’. 3D printing should allow less material waste and a vast reduction in the manufacturing complexity of personalised goods. Production systems based on 3D printing can be highly decentralised, facilitating relocation in close proximity to customers. Furthermore, the increased pervasiveness of data created in real time would permit the forecasting of maintenance requirements and the generalisation of predictive and even remote maintenance. Improved automation technology (sensors, AI, etc.) is expected to boost the autonomy of robots in handling increasingly complex tasks. Finally, CAV technology does not exclude industrial vehicles, so the widespread use of automated forklifts and trucks could become a reality within the next decade.

One estimate (Roland Berger 2016: 7) puts the combined cost savings of digitalisation at ten to twenty per cent, with the most significant reductions in costs related to inventories (thirty to fifty per cent) and complexity (sixty to seventy per cent). Meanwhile, manufacturing, logistics and quality costs are also each forecasted to decrease by ten to twenty per cent.

4.2 Employment impacts of the digitalisation of the production process

Cutting labour content is one of the major goals of digitalisation in manufacturing. Digitalisation is explicitly associated with solving the problem of ‘labour intensive, inflexible and expensive production’ and is said to be necessary in addressing the permanent challenge of securing competitiveness, itself associated with lower ‘labour cost shares’ (Roland Berger 2016: 3). The degree of employment decline will, of course, depend on how many processes are automated and to what extent, as well as on the productivity gains although, as pointed out in Table 4, these are likely to be considerable. This remains largely unknown, despite the idea occasionally being peddled of completely automated future factories.

In production, many already visible trends are putting pressure on employment levels and on existing competences: the increased automation of assembly lines and logistics activities and the development of machinery able to handle multiple operations; the push toward polyvalence and the reconfiguration of maintenance activities; connected digital instruments for control and oversight; and organisational innovations dedicated to increased automation. In the long-term, the effects will be exacerbated by the development of connected production systems involving multiple plants, the generalisation of predictive maintenance and the advent of self-correcting interconnected machinery.

Digitalisation implies a decrease in direct manufacturing employment and an increase in employment related to support functions, including internal and external coordination or the monitoring of robots and computer programs. Such workers would handle fewer assembly and more maintenance activities, they would have to
deal with an increasing number of machines and operations and they would need less mechanical and more IT skills. Therefore, the overall impact should be similar to that of EV and CAV technology, although in a much more clear-cut manner: reduced levels of employment and limited compensation via the creation of more skilled jobs. Such developments due to digitalisation are already apparent in many enterprises.

Table 4  **Strong productivity growth in production and R&D**

<table>
<thead>
<tr>
<th>Production</th>
<th>R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Today</strong></td>
<td></td>
</tr>
<tr>
<td>Robotisation in production lines and logistic activities</td>
<td>Automatisation of some development activities (Ex. numerical test/physical)</td>
</tr>
</tbody>
</table>
| Evolution of production support team | New tools and ways of development (virtualisation, PLM, built to print...)
| New organisations | New organisational setup (interdisciplinarity, more coordination between vehicle functions, data valuing) |
| **Not generalised yet** | |
| Connected systems of production | |
| Predictive maintenance | |
| Smart equipments | |
| More technicity to assist connected plants | |

Source: Syndex.

Automation will also stretch to R&D activities (e.g. digital testing will replace at least some of today’s physical testing). Growth in virtualisation, 3D printing and product lifecycle management will require new competences and these could also have a negative impact on R&D employment. This is expected to be at least partially mitigated by a renewed focus on interdisciplinarity, user experience, data management and coordination between R&D, production and sales.

5. **Conclusions**

As the post-crisis recovery peaks, the European automobile industry is facing several challenges and threats. It is not an exaggeration to say that the future of this core pillar of the European economy is at stake. Automobile manufacturers and suppliers are up against a technological upheaval fuelled by powertrain electrification, by the ‘mobility revolution’ springing from connected and autonomous vehicle technology and by continued digitalisation in production. Table 5 sums up the combined effects of the three big transformations facing the automobile industry. Compounding these, there is a stagnating internal market and an increasingly fragile position in export markets, as well as the risk of new entrants – most notably, high-tech giants and startups – capturing the lion’s share of the value chain of the vehicles of the future. Addressing each of these issues will require significant efforts and capital expenditure, especially in R&D, with limited potential for synergies. Except perhaps for the digitalisation of production, these technological transformations involve considerable uncertainty regarding the future size and structure of the European automotive industry, with radical scenarios emphasising a near-total transformation of the entire automobile
ecosystem (from the upstream supplier industry to the place of the passenger car in everyday life). Other scenarios emphasise a separation between connected and autonomous cars for car sharing on the one side and vehicles dedicated to particular uses – daily and long-distance trips, or both – on the other.

Table 5  The combined effects of powertrain electrification, connected and autonomous vehicle development and the digitalisation of production in the automotive sector

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>R &amp; D</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volumes</strong></td>
<td>Stagnation and risks on export's volume</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td><strong>Electrification</strong></td>
<td>Simplification of production</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td>Fewer, but more autonomous and connected cars</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td><strong>Industry of the Future</strong></td>
<td>Much improved productivity</td>
<td>↓</td>
<td>↑</td>
</tr>
</tbody>
</table>

Source: Syndex.

New major players – dedicated battery producers and mobility service providers – are already present on the scene and there is a major risk that some of today’s important actors will not be around in a couple of decades’ time. This is especially valid for the supplier industry, where some companies already lag behind in terms of technology. Vital questions regarding how quickly ICE technology will be phased out, how long the hybrid transition will actually last, how permissive the regulation will be concerning connected and autonomous vehicles, and what will happen to existing business models under the pressure of shared and autonomous vehicle technology, are still subject to speculation.

In terms of employment, these transformations imply fewer and different jobs compared to today. At each level – design, production, services – enterprises will have to manage departures and recruitment as well as the transformation of jobs and organisational setups.

The question of professional mobility ultimately concerns each employee to a different degree. At the least, we are dealing with changes in certain tasks and, in many cases, with changes in job content and in the level of autonomy on the job. In certain cases, reconversions will be radical, involving shifts to entirely different fields both within and outside enterprises, as well as within and outside the automotive sector. Such transformations require a comprehensive reassessment of the value of jobs and competences.

In such a shifting and complex context, anticipation and consultation constitute indispensable tools in facilitating professional mobility.

Although it will remain attractive, the automotive industry will no longer generate as many jobs as it has in the past. To mitigate the impact, rapid action has to be taken
to push those regions that will be affected by the transformation of the automotive industry to seize the existing opportunities in industries tied to renewable energy.

In the field of R&D, transformations are already underway. In the face of the diversity and novelty of technologies needed for the development of the vehicles of tomorrow, R&D employment is already growing. This is especially the case in the fields of software development, data analysis, big data and powertrain electronics. Competence scarcity in these domains will push up employment costs although this will, at least partially, be compensated by a decline in the number of powertrain R&D programmes.

After 2021, we estimate that R&D employment needs will become less stringent. By then, the transition to the Euro 7 emissions standard will, in terms of R&D, be mostly complete while internationalisation, a reduction in the number of platforms and the development of increasingly simple BEVs will reduce some of the pressure on automotive R&D activities.

In production, each new platform provides the opportunity to invest in greater automation, leading to a decline in employment. In parallel, work will become more intense for manual workers (more tasks, increased versatility) while it will limit the need for supporting functions, allowing these to become more complex and more focused on the management of unforeseeable factors.

As far as service provision is concerned, digital instruments will reduce the employment requirements for many administrative tasks but, at the same time, the development of mobility solutions will force industry actors to develop their know-how and competences.

The social partners thus have multiple subjects to discuss and negotiate: strategies for the future, organisational setups, job content, new competences, approaches to valuing labour, internal training plans, time-off for external training, securing professional career trajectories...

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PWC (2018b) Digital champions: how industry leaders build integrated operations ecosystems to deliver end-to-end customer solutions. https://www.strategyand.pwc.com/industry4-0

All links were checked on 5 August 2019.